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(54) Title: IMPROVEMENTS RELATING TO COLOUR MEASUREMENT

(57) Abstract

A colour referencing system is provided whereby a process colour is first defined in terms of percentage levels of a number of base colours to create a standard reference, an ink mixture is experimentally defined for a flat colour which corresponds in appearance to the process colour and the CIELAB or other colour difference equation value is determined by conventional means for that matched colour. Such a system is only possible if the process colour reference standard can be repeated without error. The illustration of the process colours in relation to their standard reference is therefore ideally achieved by the system as is defined in European Patent Number 0119836. It is then possible to start from a flat colour produced by single ink printing and reproduce this exactly as a process colour by a predetermined combination of four colours using particular screened percentage values.

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"Improvements Relating to Colour Measurement"

In printing, colours can be produced in two ways:

(1) By using pigmented inks in a range only limited by the availability of pigments, to produce so called flat or solid colours by a single mix.

(2) By printing a smaller set of these colours using for example only the pigmented colours of cyan, magenta and yellow together with black. This method produces colours by using solid and/or screened values defined in percentage terms of the four inks superimposed one on the other. These are so called process colours.

Conventionally colours can be measured by means of one of various types of colour difference equations to give colorimetric values by a standard code such as that known as CIELAB numbers. This particular classification incorporates a combination of three factors which create a particular visual effect of a colour namely, (A) its hue, (B) pigment saturation level or degree of separation and (L) the degree of lightness which is a function of the ink thickness or density. The CIELAB standard for any particular colour can be measured by a number of known existing scientific methods. CIELAB numbers can be calculated from colours produced by either of the above methods. While such a code, if identical for two colours produced by both methods, would indicate that the colours are the same, there is no simple method of defining both the ink mix for the flat colour and the percentage values for the process colour which would be

necessary to achieve these equivalent results.

Moreover it can be shown that although it is possible to start with a process colour and duplicate this as a flat colour by finding a given ink mix to achieve the same CIELAB numbers, the reverse is not true. There is no known method by which it is possible to start from a flat colour produced by the first method and reproduce this exactly as a process colour by any combination of the four colours using screened percentages of any value.

It is the object of this invention to provide a means whereby an adequate reference system of printed process colours can be duplicated by single ink flat colours to the same visual appearance and substantially identical colour difference equation values. Such a system then provides a simple means of producing a range of colours by either method without further calculation. This would enable a printer to create a flat colour which is equivalent to a process colour being used (and vice versa), where colour matching is necessary when printed material is being produced by differing methods.

Accordingly this invention provides a colour referencing system whereby a process colour is first defined in terms of percentage levels of a number of base colours to create a standard reference, an ink mixture is experimentally defined for a flat colour which corresponds in appearance to the process colour and the colour difference equation value is determined by conventional means for that matched colour.

Such a system is only possible if the process colour reference standard can be repeated without error. The illustration of the process colours in relation to their standard reference will ideally be by the system as is defined in our existing European Patent Number 0119836.

In determining the equivalent flat colour for a particular process colour a spectrophotometer could be used to give an approximate measurement of the process colour and a possible flat colour mix could be calculated by a suitably programmed computer. This might give a number of possible choices of mixes of pigment to make a flat colour. These can be prepared and then compared by eye with the process colour. A skilled operator can then make the necessary small adjustments to the mixes to bring the flat colour as close in appearance to the process colour as it is possible to judge by eye.

An advantage of this method is that the number of pigments required for ink mixing purposes for the process colour method is largely confined to three or four colours. A most important advantage is that both sets of colours can be precisely defined in colorimetric values by their CIELAB codes. A further advantage is that the CIELAB value of the basic inks CYAN, MAGENTA, YELLOW and BLACK are precisely maintained to existing major international colour standards which are closely monitored and strongly supported.

It has already been shown that the particular process colour arrangement of European Patent Number 0119836 allows for percentage specifications to be adjusted for a number of

differing printing conditions in order that the reference process colour remains the same. Similarly it is possible to achieve the same colours by the flat colour method by adjusting ink formulations to allow for printing conditions which change by reason of differing substrates. Thus further calculations can be made to allow for circumstances which will vary the appearance of a colour. For example, a flat colour mix will give a different appearance when applied to coated stock paper as compared to its use on unprepared stock paper. The formula for the required flat colour (and its relevant CIELAB number) could be calculated separately depending on whether the colour is to be applied to coated or uncoated stock paper.

There could also be a variation in dot gain for the process colour depending upon the screen size and other printing factors, such as the ability of the paper to absorb the ink. Calculations could be made therefore to determine modifications of the percentages of the base colours used, for particular operational variations, to create a desired process colour which has the required visual similarity to the flat colour having a particular defined CIELAB number.

Once the required referencing of the process colours to flat colours, and variations for differing printing conditions and substrates, has been determined, in order to relate the colours formed by the two processes to the relevant CIELAB number, various additional systems can be envisaged. For example look-up tables can be created for various paper stocks to which the colours may be applied.

The user can then select the correct formulation for a particular colorimetric value as defined by the relevant CIELAB number for a particular paper stock. Furthermore, programming control of the print heads of the printing press is possible to adjust the ink levels digitally to create a colour having the required CIELAB number. Indeed, the print head control could be determined from a direct reading from a spectrophotometer and densitometer applied to a particular colour which is to be matched. The reading (equivalent to a particular CIELAB number) will then be used as the control parameter to program the print heads outputs. This applies to the creation of both the process colour or the flat colour, for which suitable software control programs can be created and correlated with one another. This control is normally measured by density. The present concept therefore allows for better calibration and control of the printing machine.

It will be appreciated that the comparison with a standard set of printed process colour references may be made by this invention not only with other printed colours but also with colours achieved by any process. Also the system may be used for process colours created not only by dot screen printing but also by line printing such as with a laser printer.

Whilst reference has been made throughout the specification to CIELAB numbers, this is merely one particular system of a colour difference equation (although it is presently the most popular) from several which are used in

the printing industry. Consequently, where the term CIELAB number or value is used this is intended to imply any standard number or value as defined by any colour difference or transformation equation which provides an adequate evaluation of a range of colours for which a correlation between the process colour and the flat colour is required.

CLAIMS

1. A colour referencing system whereby a process colour is first defined in terms of percentage levels of a number of base colours to create a standard reference, an ink mixture is experimentally defined for a flat colour which corresponds in appearance to the process colour and the colour difference equation value is determined by conventional means for that matched colour.

2. A system according to claim 1, wherein the illustration of the process colours in relation to their standard reference is by the system as is defined in European Patent Number 0119836.

3. A system according to claim 1 or claim 2, wherein a spectrophotometer is used to give an approximate measurement of the process colour and possible flat colour mixes are calculated, such as by a suitably programmed computer, prepared and compared by eye with the process colour, with any necessary small adjustments to the mixes being made to bring the flat colour as close in appearance to the process colour as it is possible to judge by eye.

4. A system according to any one of claims 1 to 3, wherein ink formulations are adjusted to allow for printing conditions which change by reason of differing substrates, or by variation in dot gain for the process colour depending upon the screen size and other printing factors.

5. A system according to claim 4, wherein look-up tables are created for various paper stocks to which the

colours may be applied.

6. A system according to any one of claims 1 to 5, wherein programming control of the print heads of the printing press is provided to adjust the ink levels digitally to create a colour having the required colour difference equation number.

7. A system according to claim 6, wherein the print head control is determined from a direct reading from a spectrophotometer and densitometer applied to a particular colour which is to be matched.

8. A system according to claim 7, wherein the reading is used as the control parameter to program the print heads outputs.

9. A colour referencing system according to claim 1, and substantially as herein described.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 91/00204

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[5]: G 01 J 3/52, B 41 M 1/18

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[5]	B 41 F, B 41 M, B 44 D, G 01 J

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	EP, A, 0119836 (GORDON PHILLIPS) 26 September 1984 see abstract; page 9, lines 1-6; page 15, lines 7-14; page 19, lines 3-12 cited in the application	1-4,9
A	EP, A, 0324718 (GRETAG) 19 July 1989 see page 3, lines 38-52; page 4, lines 6-13; figure 1	6-8
A	Deutsche Normen: DIN 16539, October 1971: "Europäische Farbskala für den Offset-druck" see the whole document	1,3
A	Journal of the Optical Society of America, vol. 68, no. 8, August 1978, Optical Society of America, H.R. Davidson: "Preparation of the OSA uniform color scales committee samples", pages 1141-1142 see page 1141, left-hand column, paragraph 2	1

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
3rd May 1991	21 JUN 1991
International Searching Authority	Signature of Authorized Officer
EUROPEAN PATENT OFFICE	MISS T. TAZELAAR

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9100204 SA 44311

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 19/06/91
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A- 0119836	26-09-84	US-A- 4629428	16-12-86
EP-A- 0324718	19-07-89	JP-A- 1225554	08-09-89
		US-A- 4975862	04-12-90
		AU-A- 2851989	20-07-89